

Table III.—Various Brands of Iron and Steel heated at 230° C.

No. of specimen ...	1.		2.		3.		4.	
Time of heating, days.	Hysteresis.		Hysteresis.		Hysteresis.		Hysteresis.	
	Abs.	Incr. per cent.	Abs.	Incr. per cent.	Abs.	Incr. per. cent.	Abs.	Incr. per cent.
0.....	600	0	600	0	910	0	1090	0
1.....	1190	98	730	22	860	—8	1490	37
2.....	1100	77	800	33	940	3	1450	33
4.....	1030	72	750	25	890	2	1390	27
9.....	1000	67	770	28	880	3	1420	28
11.....	..	..	770	28	900	1	1370	24
15.....	..	..	750	25	910	0	1320	19

“On the Topographical Anatomy of the Abdominal Viscera, especially the Gastro-Intestinal Canal in Man.” By CHRISTOPHER ADDISON, M.D., B.S. (Lond.), F.R.C.S., Professor of Anatomy, University College, Sheffield. Communicated by Professor ALEXANDER MACALISTER, F.R.S. Received October 15—Read December 8, 1898.

(Abstract.)

General Purpose.

This paper embodies the results of an enquiry into the topographical anatomy of the abdominal viscera in man. The work falls into two main parts. First, that dealing with the relations of the viscera to the surface of the body ; and, second, that dealing with the relations of the viscera to one another.

With regard to the first part: It is to be remarked that the methods of mapping out the abdomen at present in general use are open to certain objections ; for the reasons that the lines used to divide the abdomen transversely are drawn at variable distances from one another, the variation not being determined by the dimensions of the body ; that the points between which the upper transverse abdominal line is drawn are very variable in their level, so that in some cases the transverse lines come very near together leaving a large part of the abdomen above them not mapped out ; in other cases the lines may be far apart ; and, moreover, the points between which the upper transverse line is to be drawn are not always easily determined, and it happens

that in many cases the line, if drawn correctly, is not horizontal. For these reasons the transverse lines as fair and uniform divisions of the abdomen, and as guides to the deeper parts, lose very much value. Further it is desirable for practicable purposes that the determination of the positions of parts of the viscera in regard to the surface by measured distances, in centimetres or inches, as so much above, below, to the right or left of certain points or lines is to be avoided as much as possible, seeing the very great variations that occur in the dimensions of the trunk even in adults.

The author has therefore sought to elaborate first some method of abdominal surface-marking which shall be independent of the variable surface points, which shall be unvarying and uniformly proportionate to the size of the trunk, which shall be easily determined and in which the lines used to divide the abdomen shall be possessed of such constancy both in regard to the bony skeleton and the viscera that they themselves become reliable land-marks.

With regard to the second part of this enquiry: Many very accurate measurements of the position of individual organs or parts with regard to the surface of the body are recorded. But it is of great importance that, in any one case, not only the position of any one organ should be recorded, but that of all the other organs or parts in its neighbourhood, for in this way only can we discover the degree of interdependence in the positions of the various organs, and the extent, if any, to which when they are enlarged, or diminished in size, or displaced, they tend to cause alterations in the positions of the various neighbouring organs; and, from the clinical point of view, it is perhaps as important to determine that changes in the shape or position of any one organ do not tend to cause alterations in the position of any other particular organ, as to determine that they do. In the second part of this enquiry therefore, by studying and comparing a series of cases, the author has endeavoured to determine the forces which maintain the various mutual relations of the abdominal viscera or which cause alterations in shape or displacements of them either as a whole or with regard to one another. And in this connection has been considered, in the same manner, the position, and changes in position, of the various lines of the peritoneal attachments to the body wall.

Method.

For obtaining the maps of the viscera the bodies of forty subjects, taken consecutively, were examined in the fresh state, with the exception of two bodies that were hardened before examination by fluid injections. In all but a few cases, the examination was within thirty hours after death. The examination was conducted in the following manner:—Tables were prepared in each case recording the stature of the individual,

the general condition, the cause of death, the dimensions of the trunk in various directions, the distances from one another of the various bony and other surface points and their relations to the lines used to divide the abdomen, and various other general and particular facts. At the end of the examination the relations of the various surface lines to the vertebral column and the parts at the back of the abdomen were measured and recorded, as will be explained. These tables are presented in an appendix as the *Individual Case Tables*.

The different bony and other surface points, the parts of the costal arch, and the lines used to divide the abdomen in their appropriate positions were then drawn on the life-size scale on large sheets ruled in centimetre squares.

The abdomen was divided vertically by three lines, a middle line and two lateral lines, one drawn upwards on each side through a point midway between the anterior superior spine of the ilium and the middle line. Lines were drawn transversely across the trunk through points a quarter-way, half-way, and three-quarters of the way along a tape drawn from the pubes to the supra-sternal notch. The lower two transverse lines were abdominal. Steel pins 14 inches long, sufficiently thick, so as to ensure rigidity, and with long well-sharpened points, were then hammered through the abdomen at right angles to the table, into which they were driven when they failed to fasten themselves in the bony skeleton. Six pins were driven through the abdomen; three in each transverse plane, one on the middle line and one in each lateral line.

The anterior abdominal wall was then cut free of the pins and reflected so as to completely expose the parts beneath.

The various viscera and other parts were then measured in relation to the pins in various directions at the point of transfixion, and a life-size outline of them made on the ruled sheets. No parts were disturbed before measurement, and they were cut away piecemeal, as required, to expose the parts beneath. In this way, at length, a complete map of all the viscera was obtained in relation to the pins projecting the surface-marking through the abdomen. The same applies to the lines of the peritoneal attachments. Subsidiary drawings were made, as might be required, of peritoneal pouches or other parts, and of the viscera from different aspects. At the end of the examination the relations of the pins to the parts of the skeleton behind and to the brim of the pelvis were recorded and drawn. A map of the viscera was in this way obtained both in relation to the surface lines and to the different bony and other surface points, so that if the method of dividing the abdomen had been found unsatisfactory, the measurements could be transferred to any other system. Outlines of all the viscera and the chief surface points from each case are represented on one sheet on the life-size scale in the *Case Plates* of the Appendix. All

the individual separated viscera are represented, grouped along the various planes used to divide the abdomen, on the one-ninth scale in different parts of the paper; and in various other manners by means of diagrams, curves, and tables their correspondence and variations with regard to the surface and to one another are set forth. Finally, full details of all the measurements of the viscera, and their averages, are given in the *Measurement Tables* in the Appendix.

Various hardened, foetal, and adult preparations have been made to elucidate or illustrate different points in the paper.

In the course of the paper each organ is considered somewhat as follows:—Its average position in regard to the surface; its variations in regard to the surface; its average position in relation to other viscera; its different variations in regard to them; the causes of its variations; its shape and movements.

Results.

The value of the method of the proportionate division of the abdomen, already described, for the purposes of surface marking is well established. Indicating some of the chief points—

First, concerning the upper transverse abdominal line, halfway between the pubes and the supra-sternal notch:—

It is found to practically correspond with the disc between the first and second lumbar vertebræ—in 67·5 per cent. of the cases it was within half an inch of this disc; its greatest distance from the disc, and that only in one case, was 1 inch. It corresponded in the average at the costal arch with the tip of the 9th costal cartilage; but it is superior to that part for surface-marking purposes because (*a*) its vertebral variation was not so great, and (*b*) it can always readily be obtained, whilst the tip of the cartilage in many subjects cannot be localised.

In regard to deeper parts, a horizontal plane at this level (*a*) practically bisects the stomach as it overlies the middle line in the average of cases.

(*b*) In 72·5 per cent. of the cases it was correct as a guide to the level of the pylorus; in these cases either passing through the pylorus or corresponding with one of its borders.

(*c*) In the right lateral line it represents the place where the gall bladder overlies the duodenum, and, when the liver is not enlarged or displaced downwards, the plane passes just above the highest point of the hepatic flexure of the colon.

(*d*) To the left of the middle line, nearly halfway between the middle line and the lateral line, it indicates the highest point of the duodeno-jejunal flexure and the upper border of the mesentery, which in 85 per cent. of the cases were not situated more than 2 cm. away from the plane one way or the other.

(e) It almost invariably crosses some part of the head of the pancreas, usually about its upper third, and in the left lateral line it represents, in the average, the anterior border of the pancreas, this part being, in 70 per cent. of the cases, at or within 2 cm. of the plane.

(f) In the left lateral line it represents, in the absence of a distended stomach, the anterior border of the pancreas, the greater curvature of the stomach, the attachment of the transverse meso-colon, and the upper border of the transverse colon.

(g) Further to the left beneath the ribs it represents the upper part of the basal surface of the spleen.

Second, concerning the *lower transverse abdominal line*, quarterway from the pubes to the supra-sternal notch :—

It occupies a very regular position with regard to the ilium, representing practically Cunningham's intertubercular plane. It is normally situated 2 inches above the anterior superior iliac spines, and is found, in regard to these points and the highest parts of the iliac crest, to be somewhat less variable than the umbilicus. In regard to vertebræ, it is situated over the upper part of the fifth lumbar vertebra.

In regard to deeper parts :—(a) It represents the place where the psoas muscles diverge from the lumbo-sacral promontory, and passes a little above the inner attachment of the meso-sigmoid.

(b) In the right lateral line it represents the upper border of the ileo-colic junction—the inner border of the ascending colon at this point being situated immediately external to the lateral line.

(c) In the left lateral line it passes a little above the commencement of the meso-sigmoid—the inner border of the descending colon at this point being situated immediately external to the lateral line.

Third, taking a plane across the abdomen midway between the transverse lines :—For practical purposes it represents in each lateral line the lower pole of the kidney, passing a little above that of the right and a little below that of the left ; in the right lateral line it indicates the turning inwards of the peritoneum to form the commencement of the transverse meso-colon ; and in the middle line the crossing of the mesentery.

Fourth, taking a plane midway between the lower transverse abdominal line and one through the anterior superior iliac spines, it represents in the right lateral line the root of the appendix, and a little internal to this, at the pelvic brim, the lower attachment of the mesentery and the innermost point of the cæcum.

This aspect of the paper, however, need not be further enlarged upon. An indication has been given of the position of some of the more important points of various parts around which others may be easily filled in. Suffice it to say, that, as with regard to the surface lines, so the levels and variations of the different viscera with regard to the more stable surface points, such as the parts of the ilium and

the infra-sternal notch, as well with regard to the more variable parts of the costal arch and the umbilicus, were fully worked out, and are set forth in the paper.

Further, in regard to deeper parts and the various visceral displacements:—

1. *In connection with the stomach*—(a) It is found that a low position of the stomach, even combined with distension, is not sufficient to cause material downward displacement of the pylorus, but that that part, firmly bound with the first part of the duodenum to the liver requires downward displacement or enlargement of the liver—particularly of its omental tuberosity—for it to be substantially moved downwards.

(b) Lateral displacements of the pylorus also are found more related to the condition of the liver than to that of the stomach; and the evidence does not point to any considerable displacement of the pylorus to the right in the filling of the stomach. Similarly, displacements of the duodenum and the head of the pancreas to the left are associated with a low position of the lower border of the liver.

(c) Concerning the “stomach-bed” described by Birmingham, the parts behind the stomach vary with the condition of the stomach in this manner:—When the stomach is distended or situated low down, it flattens out the pancreas, increasing the vertical extent of its gastric surface and diminishing the prominence of its anterior border and the depth, antero-posteriorly, of its inferior surface; and the pancreas is further pushed down over the face of the left kidney, leaving an increased gastric surface of that organ exposed above its upper border. The reverse of all these processes takes place when the stomach is pushed upwards by distended intestines below.

(d) The stomach does not displace the left kidney downwards; in fact the position of the left kidney is not found to vary directly with that of any other organ in its neighbourhood, but is chiefly dependent for its maintenance upon the strength of its enveloping connective tissue.

It may here be mentioned, that the level of the left supra-renal body in relation to the left kidney is determined very much by the level of the pancreas with regard to the kidney. When the pancreas is pushed down over the kidney the supra-renal body follows it, but is not depressed to so great an extent; and the reverse takes place when the pancreas is pushed upwards.

2. The duodenum and the head of the pancreas have a considerable range of level compared with the vertebral column—as great as, or greater than, that of the right kidney. These alterations in level of the duodenum and the head of the pancreas are found to be chiefly related to the position and size of the liver—which, on the other hand, does not appear to be potent to displace the right kidney downwards.

3. Although the ascending colon usually makes a considerable impression on the right kidney, yet that part of the bowel is not an indispensable support of the right kidney; the bowel may be displaced away from a right kidney situated at a level, as high, or higher than usual. The right kidney is chiefly maintained in its position by the strong attachments of its enveloping connective tissue, particularly to the right crus of the diaphragm.

4. Prolapse of the mesentery is commonly associated with prolapse of the splenic flexure of the colon, but more directly associated with the condition of the liver and stomach, as far as the forces above it are concerned.

The costo-colic ligament is the chief agent in determining the position of the splenic flexure of the colon, and, though commonly giving way before a liver and stomach displaced or enlarged downwards, may maintain the position of the splenic flexure of the colon in spite of them.

5. Although in the foetus the arrangements of the coils of the small intestine perhaps generally follow certain plans, as far as these cases go, the coils do not appear to maintain these arrangements in the adult with any special uniformity.

Many other points in the paper of importance do not admit of being explained or indicated in an abstract; they are especially the parts dealing with the variations in the level of the cardiac orifice of the stomach, and the relative levels of the two orifices of the stomach—the varieties in shape of the stomach, how that there appear to be four chief types, and that the first and commonest is particularly noticed in those cases in which the transverse colon occupies a high position—the relations of the stomach to the liver—the shape and moulding of the pancreas by the stomach, and how that the presence of a well-defined omental tuberosity on the pancreas is associated with a distended and low position of the stomach, not especially with distension only—the abnormalities of the duodenum as illustrated in these cases—the position, direction, and moveability of the lower end of the ileum—the peritoneum on the large intestine—the classification of the position and attachments of the vermiform appendix, the changes in its position with regard to the caecum, and the associated conditions; and the changes in the position of the caecum itself and the associated conditions—the varieties in shape of the transverse colon; prolapse of the transverse colon and the associated conditions—the description of the meso-sigmoid, especially the length and attachments of its outer limb, and the resulting condition of the upper part of the sigmoid flexure of the colon.